ABSTRACT TEMPLATE

Title ...Dr.... (Prof. Dr. Mr. Ms) **Family Name** ...Yueh..............................

Given Name ...Simon.............................

Institution ...Jet Propulsion Laboratory..

Address ...MS 300-235, 4800 Oak Grove Drive, Pasadena, CA 91109....................

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Country ...United States.... **Post Code** .... **Phone No.** ...818-354-3012...........

Fax No. ...818-393-3077...... **Email Address** ...simon.yueh@jpl.nasa.gov................

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Abstract title: Polarimetric Radar Remote Sensing of Ocean Surface Wind

Name of author(s): Simon H. Yueh, William J. Wilson, and Steve Dinardo

Corresponding author: Simon H. Yueh

Abstract:

Experimental data are presented to support the development of a new concept for ocean wind velocity measurement (speed and direction) with the polarimetric microwave radar technology. This new concept has a strong potential for improving the wind velocity measurement accuracy under rainy conditions and for extending the useful swath width by up to 35 percent for follow-on spaceborne scatterometers to NASA SeaWinds missions. The key issue is whether there is a relationship between the polarization state of ocean backscatter and ocean wind velocity at NASA scatterometer frequencies (13 GHz).

A two-scale scattering modeling analysis has suggested that the preferential directional orientation of wind-generated ocean waves has an influence on the polarization state of electromagnetic waves scattered by the ocean surfaces. It was noted by the theoretical predictions that the correlation between the co- (S_{VV} and S_{HH}) and cross-polarized (S_{VH} and S_{HV}) radar backscatter from sea surfaces has an odd-symmetry with respect to the wind direction, unlike the symmetry property of σ_0s. If this is true, the correlation between co- and cross-polarized channels will provide additional information regarding

the direction of sea surface wind, and may enable significant enhancement to the SeaWinds-like conical scanning scatterometers. However, no radar observations were available to support this prediction.

We developed an airborne Ku-band (13.95 GHz) polarimetric scatterometer (POLSCAT) to acquire experimental evidence for the suggested polarization signature. POLSCAT was installed together with the JPL Passive/Active L-/S-band (PALS) microwave instrument designed for ocean salinity sensing on the National Center for Atmospheric Research (NCAR) C-130 aircraft. A set of flights was performed over the buoys deployed by the Monterey Bay Aquarium Research Institute (MBARI) off the California coast in August 2000. The C-130 flights were conducted over the buoys from 8 to 10 different directions to investigate the wind direction sensitivity of polarimetric radar signals. On August 16, 2000, the buoy wind was 10 m/s from the northwest over the MBARI M2 buoy. The data are plotted against the relative azimuth angle between the wind and antenna look directions. VV and HH σ_0s are symmetric with respect to the wind direction, consistent with the SeaWinds radar observations. VH and HV σ_0s of ocean surfaces, not yet reported in the literature, are also symmetric with respect to the wind direction. The other polarimetric radar measurements are the normalized correlation ($\rho_{\alpha\beta\gamma\delta}$) between $S_{\alpha\beta}$ and $S_{\gamma\delta}$ polarization. It was observed that the correlation between VV and HH, ρ_{VVHH}, is symmetric with respect to the wind direction, while the correlation between co- and cross-polarized channels is anti-symmetric. This confirms the theoretical predictions that there are even and odd symmetry properties in the polarimetric radar signals of sea surfaces. The flight conducted on August 17 yielded similar characteristics. The proof-of-concept experiment was successful and provided the following key results: (1) The microwave ocean radar backscatter is elliptically polarized at Ku band frequencies. (2) The correlation between the co- and cross-polarized radar echoes is anti-symmetric with respect to the wind direction for wind speed near 10 m/s. This complements the symmetry property of σ_0s – conventional radar measurements. The results provide evidence supporting the polarimetric scatterometer concept for ocean wind measurements.